FIG. 1

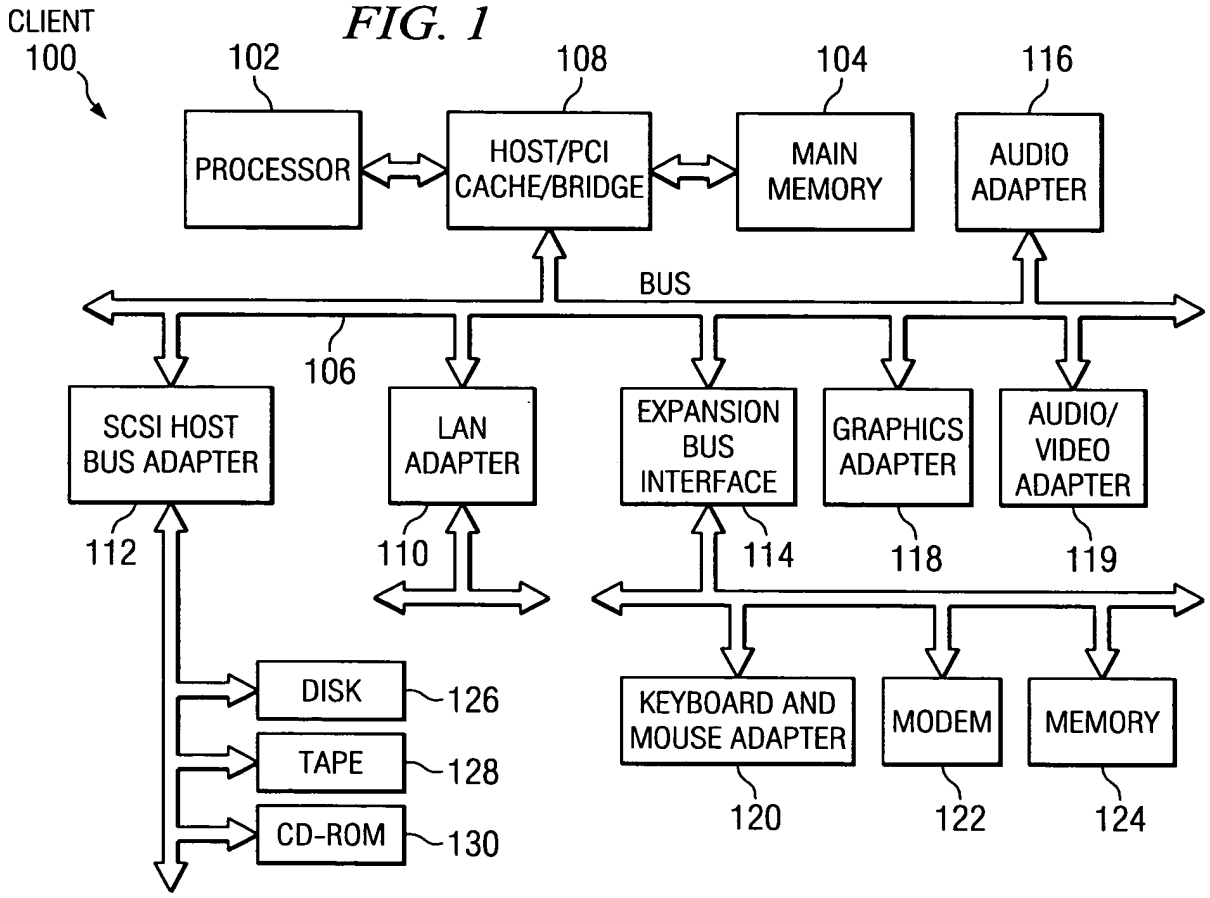


FIG. 3

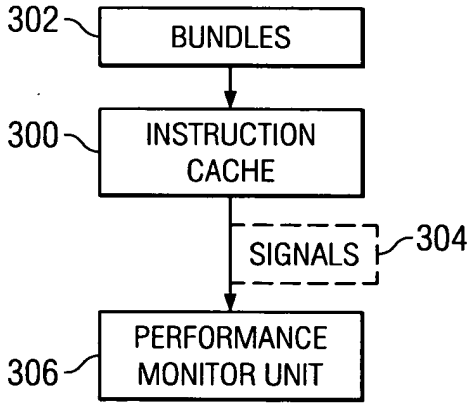
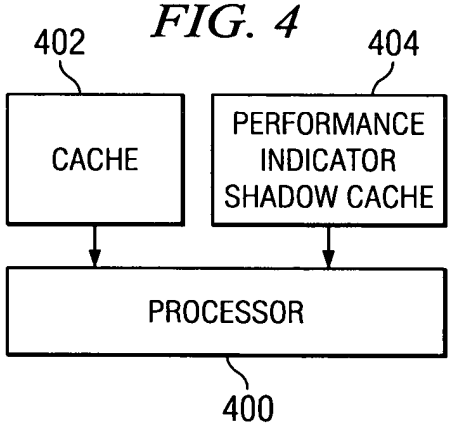


FIG. 4



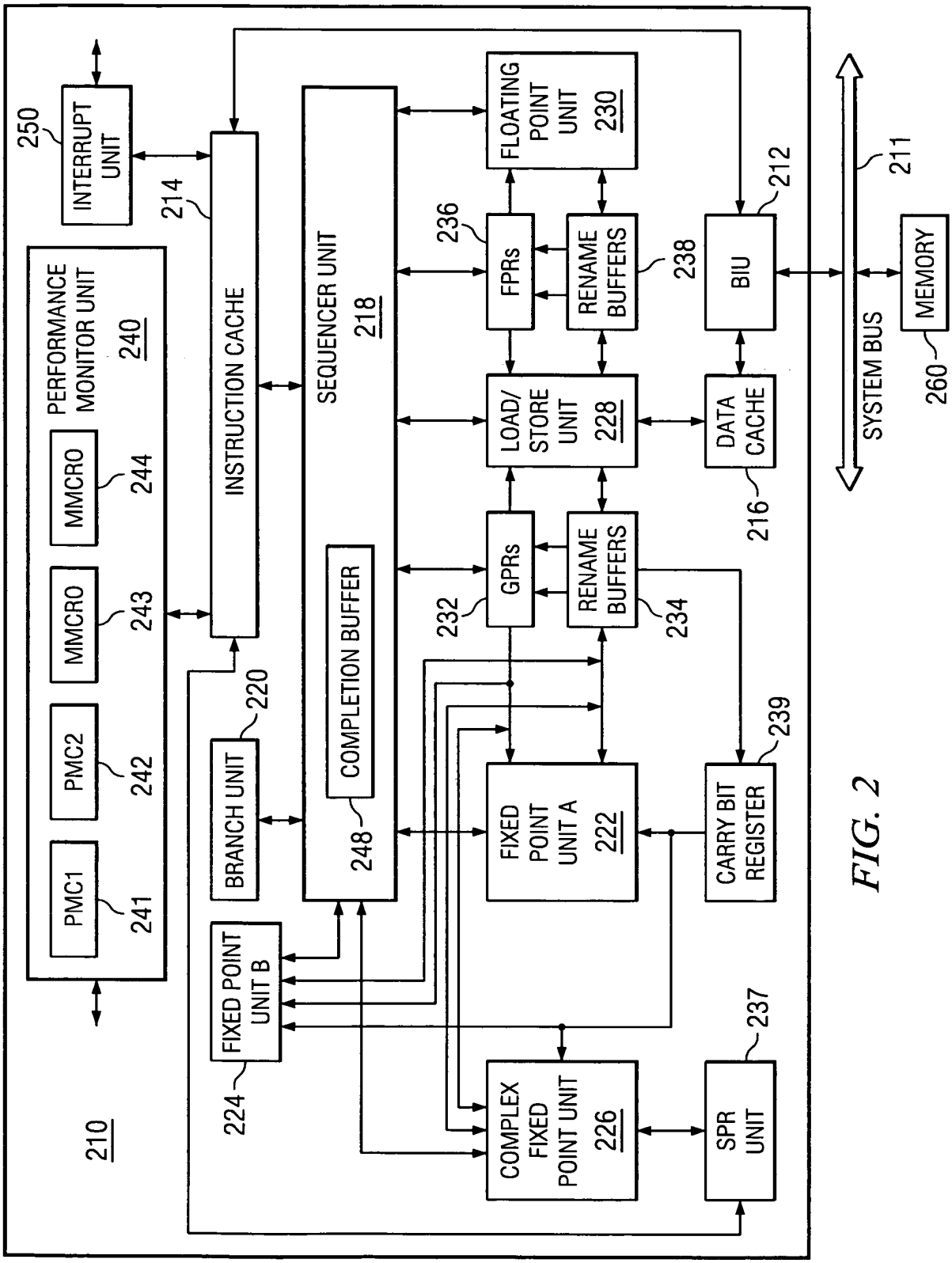

210
INTERRUPT UNIT
250
INSTRUCTION CACHE
214
SEQUENCER UNIT
218
FLOATING POINT UNIT
230
FPRs
236
RENAME BUFFERS
238
BIU
212
SYSTEM BUS
211
MEMORY
260
PERFORMANCE MONITOR UNIT
240
MMCR0
244
MMCR0
243
PMC2
242
PMC1
241
LOAD/ STORE UNIT
228
DATA CACHE
216
GPRs
232
RENAME BUFFERS
234
COMPLETION BUFFER
248
BRANCH UNIT
220
FIXED POINT UNIT A
222
CARRY BIT REGISTER
239
FIXED POINT UNIT B
224
COMPLEX FIXED POINT UNIT
226
SPR UNIT
237

FIG. 2

FIG. 5

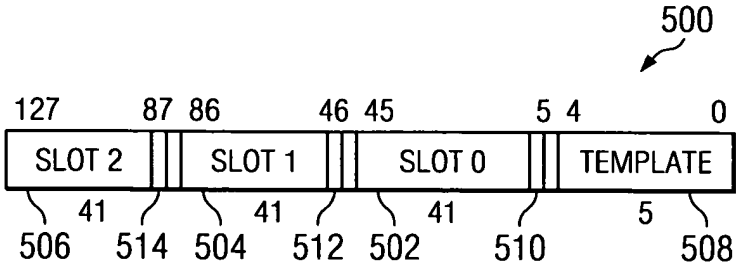


FIG. 6A

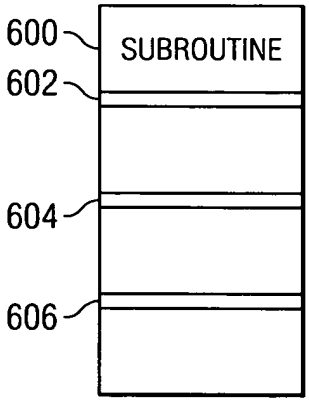


FIG. 6B

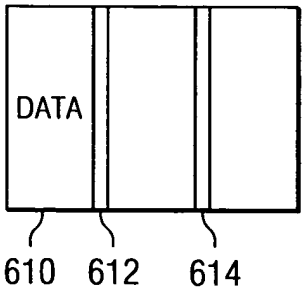


FIG. 7

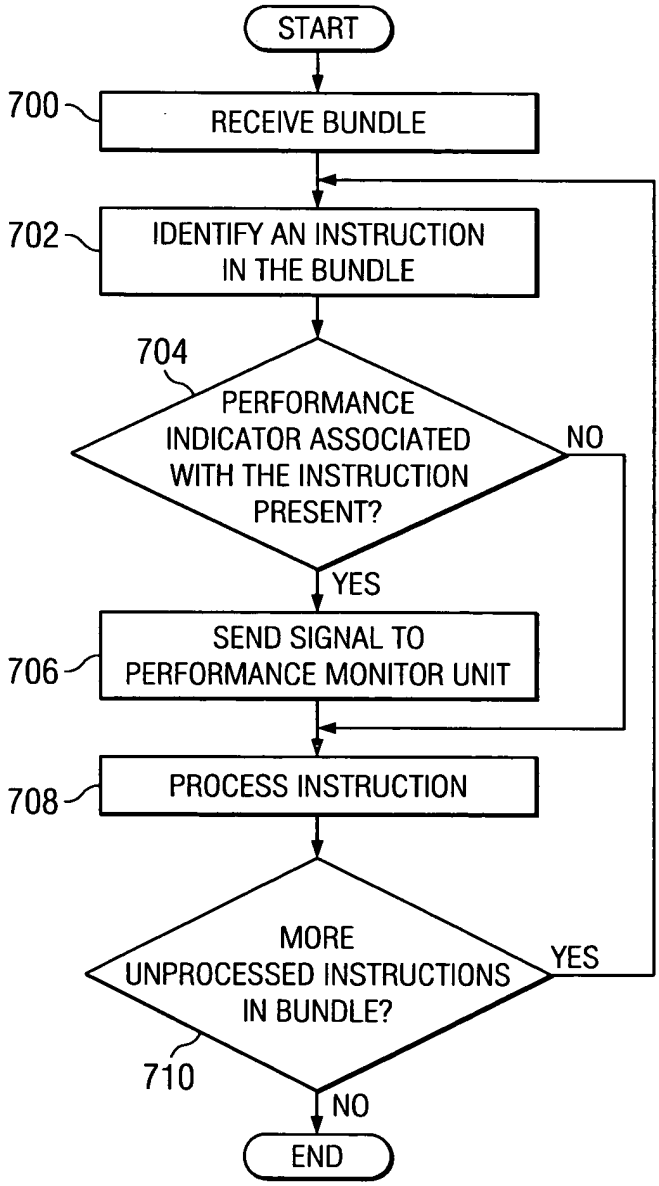


FIG. 8

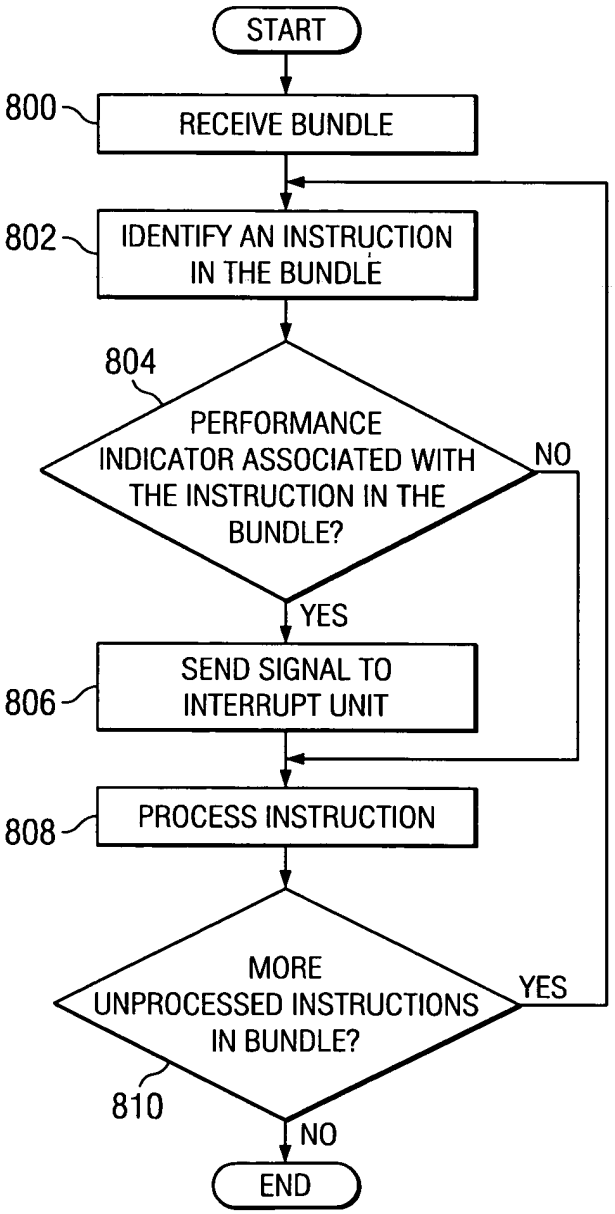


FIG. 9

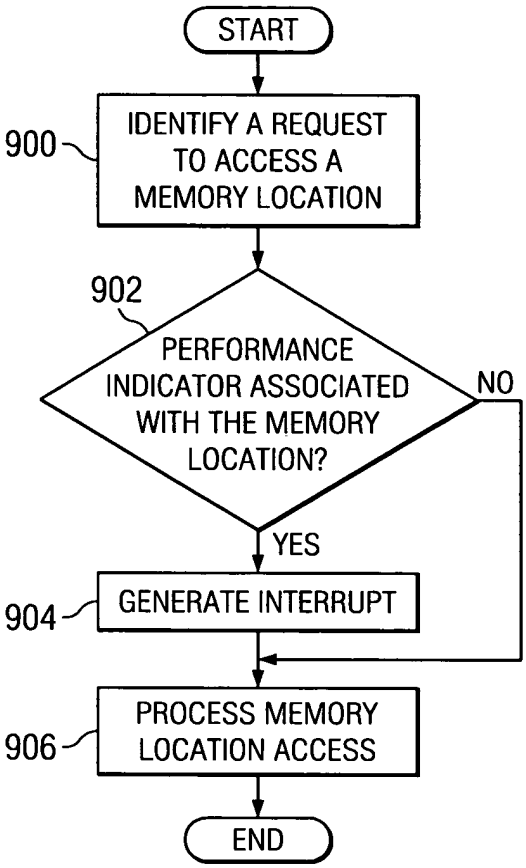


FIG. 10

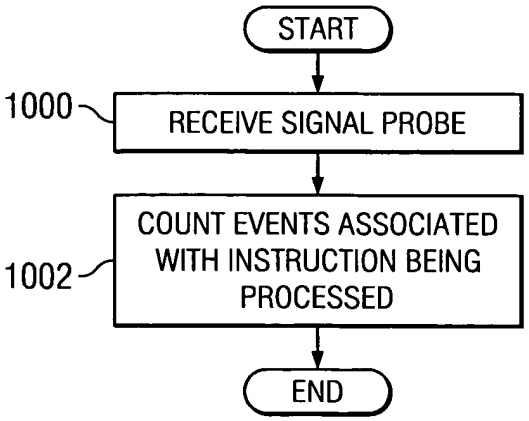


FIG. 11

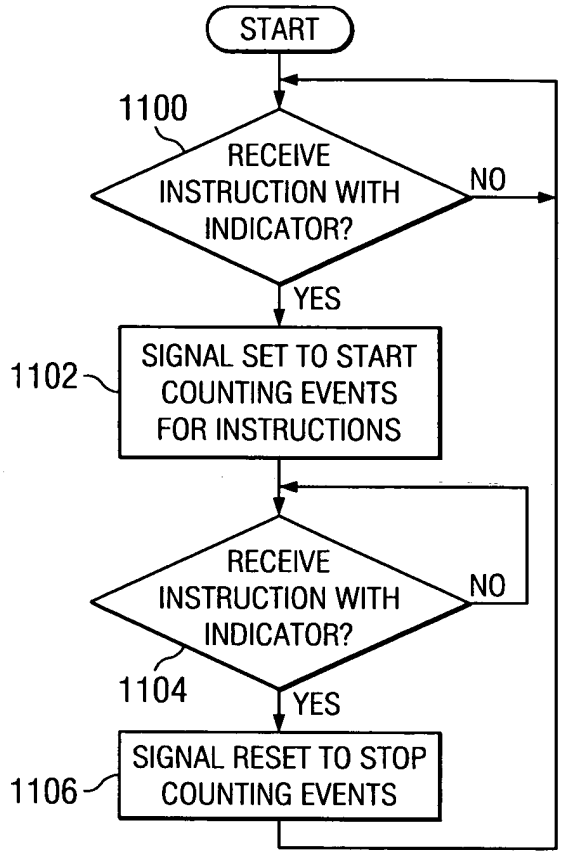


FIG. 12

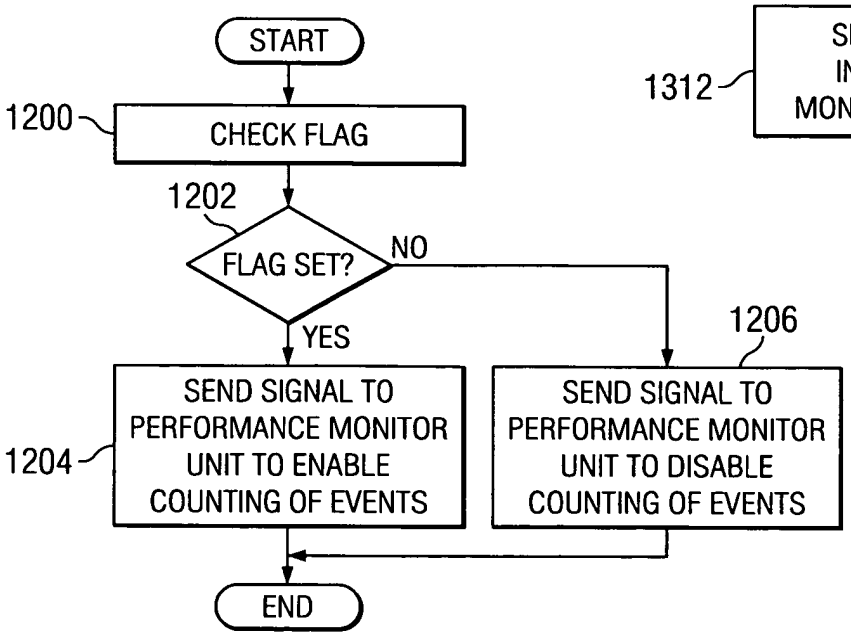


FIG. 13

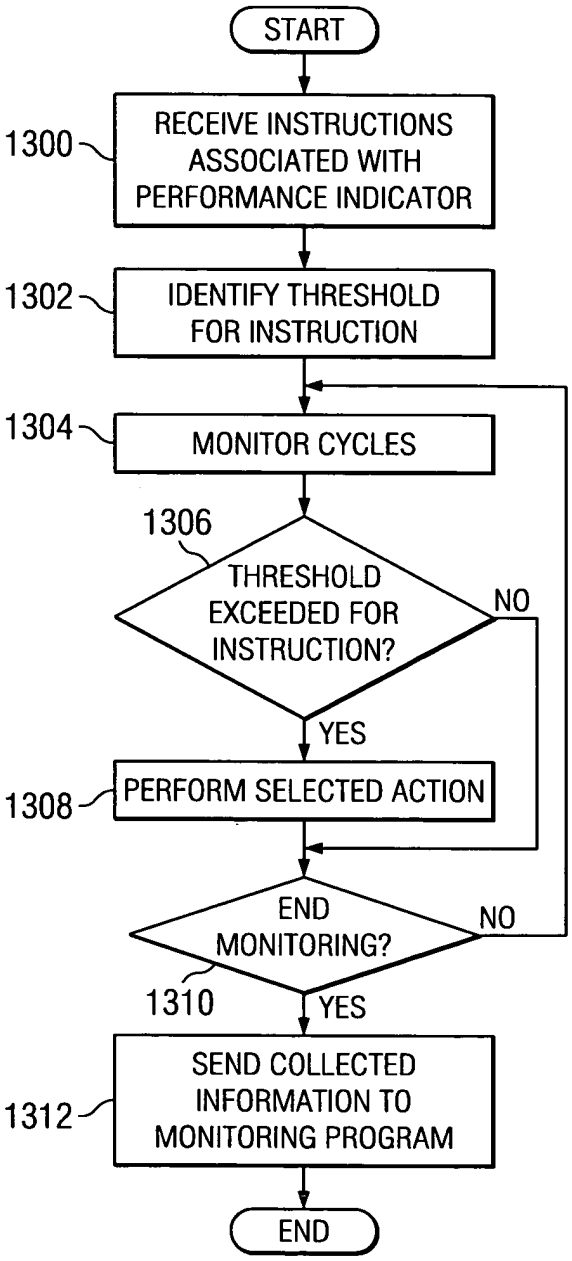


FIG. 14

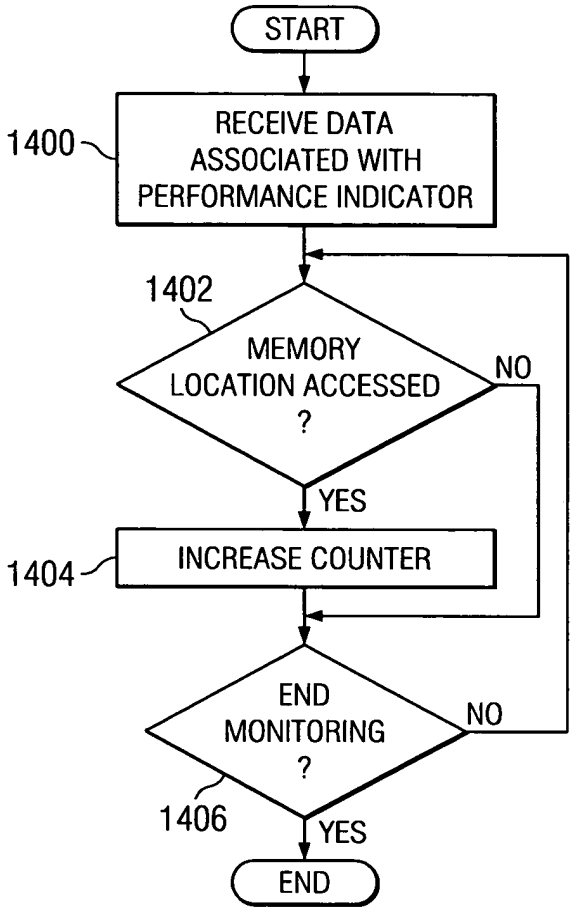


FIG. 18

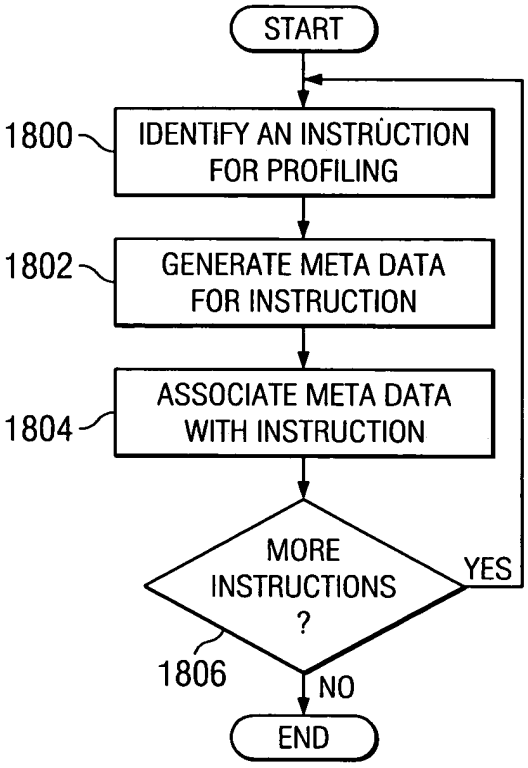


FIG. 15

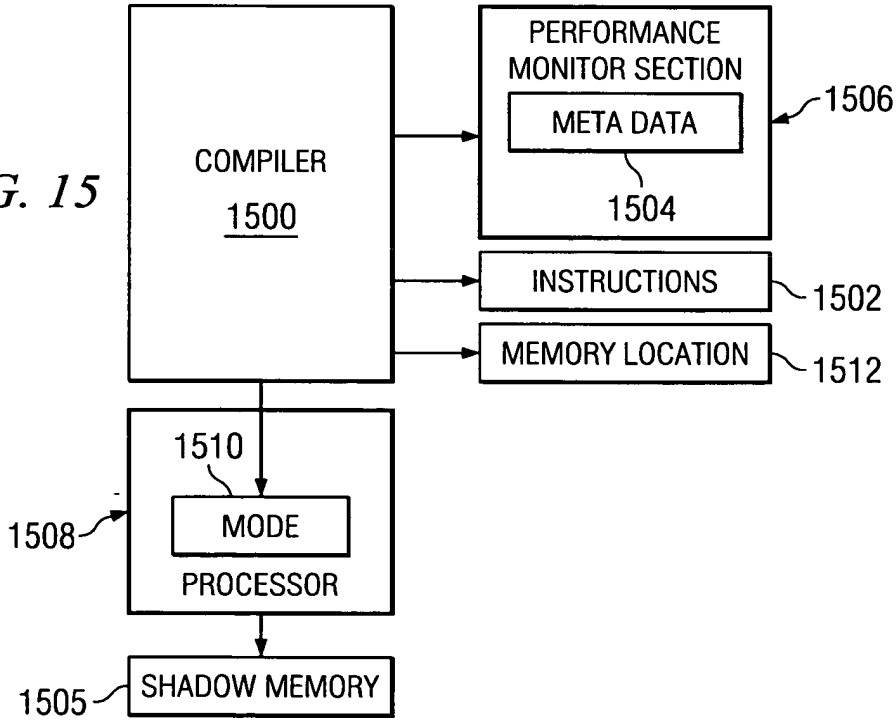


FIG. 16

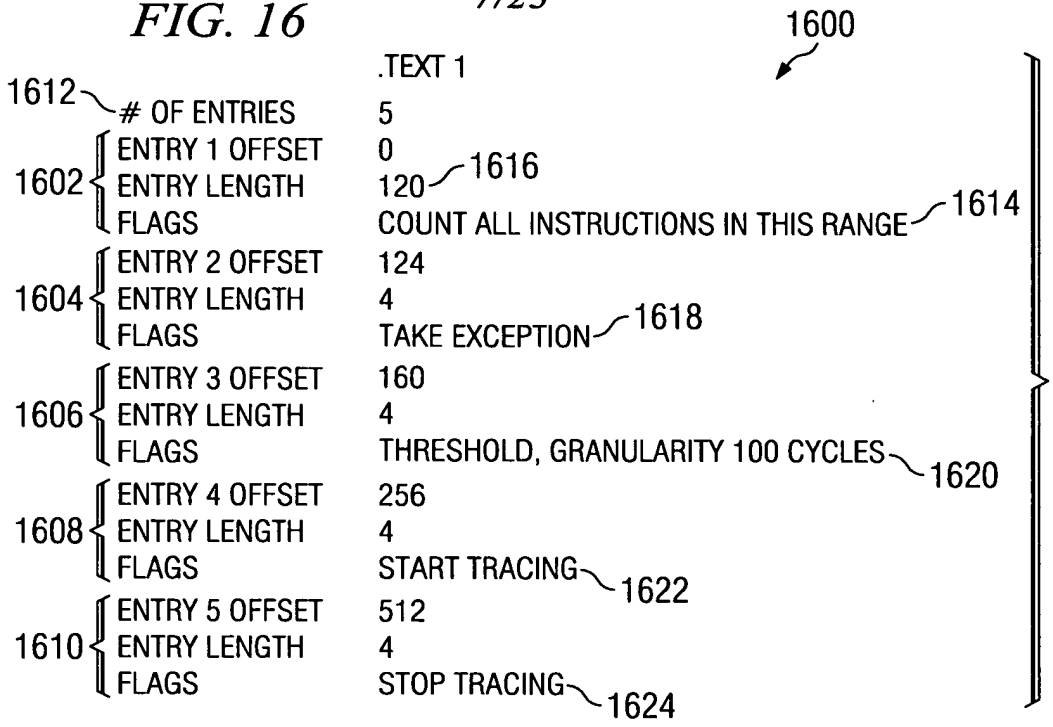

1600
.TEXT 1
1612
OF ENTRIES 5
1602
ENTRY 1 OFFSET 0
ENTRY LENGTH 120
1616
FLAGS COUNT ALL INSTRUCTIONS IN THIS RANGE
1614
1604
ENTRY 2 OFFSET 124
ENTRY LENGTH 4
FLAGS TAKE EXCEPTION
1618
1606
ENTRY 3 OFFSET 160
ENTRY LENGTH 4
FLAGS THRESHOLD, GRANULARITY 100 CYCLES
1620
1608
ENTRY 4 OFFSET 256
ENTRY LENGTH 4
FLAGS START TRACING
1622
1610
ENTRY 5 OFFSET 512
ENTRY LENGTH 4
FLAGS STOP TRACING
1624

FIG. 17

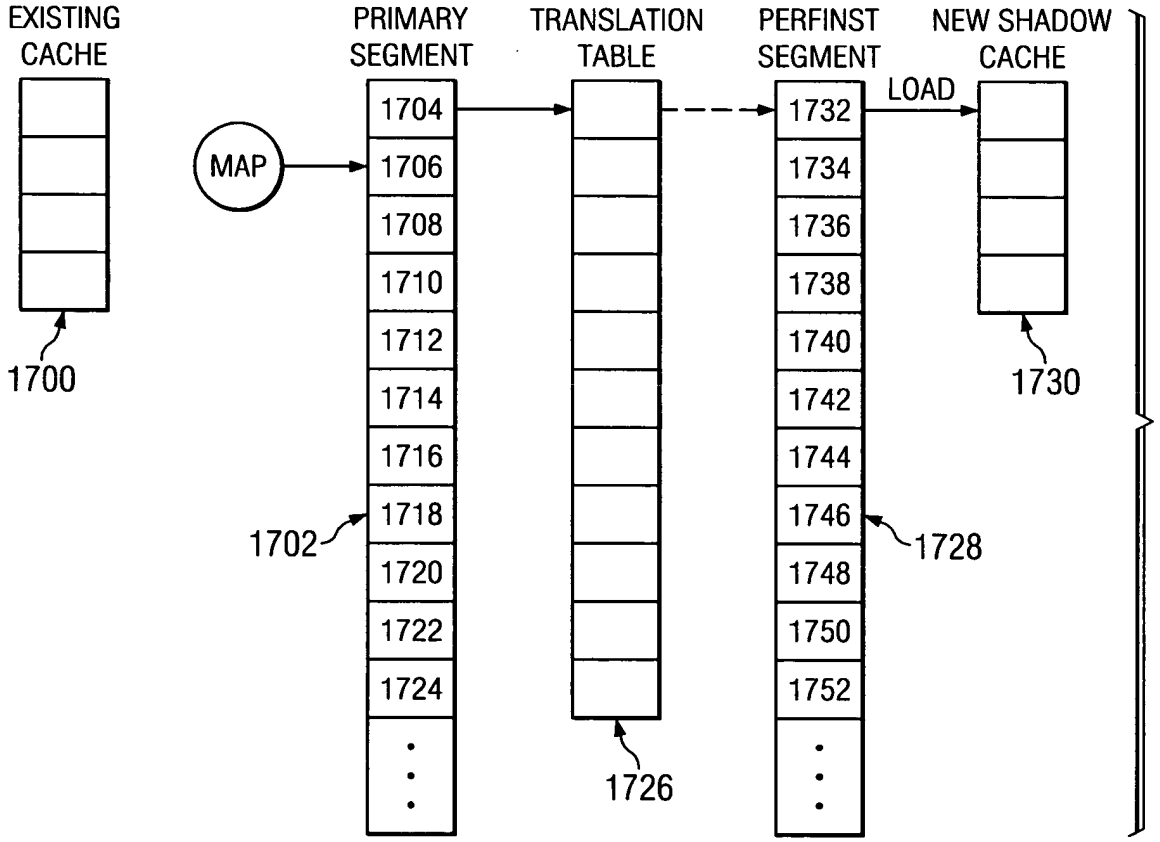

EXISTING CACHE
PRIMARY SEGMENT
TRANSLATION TABLE
PERFINST SEGMENT
NEW SHADOW CACHE
LOAD
MAP
1704
1706
1708
1710
1712
1714
1716
1718
1720
1722
1724
1732
1734
1736
1738
1740
1742
1744
1746
1748
1750
1752
1700
1702
1726
1728
1730

FIG. 19

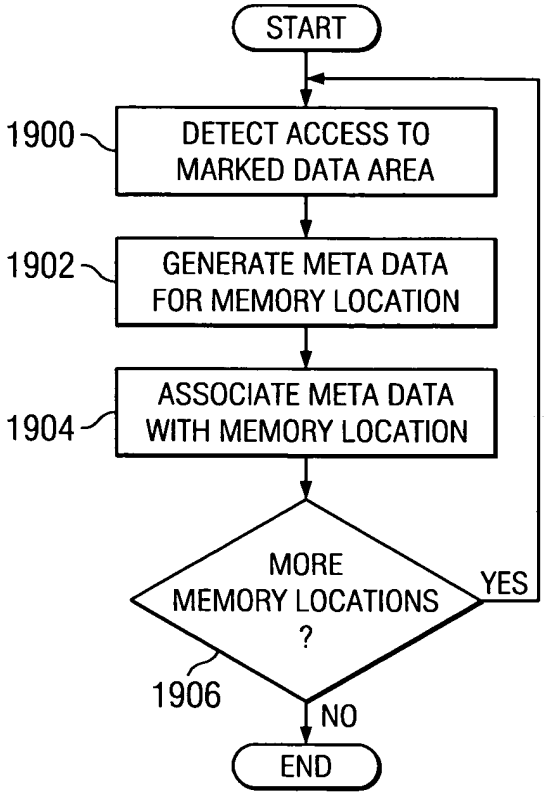


FIG. 20

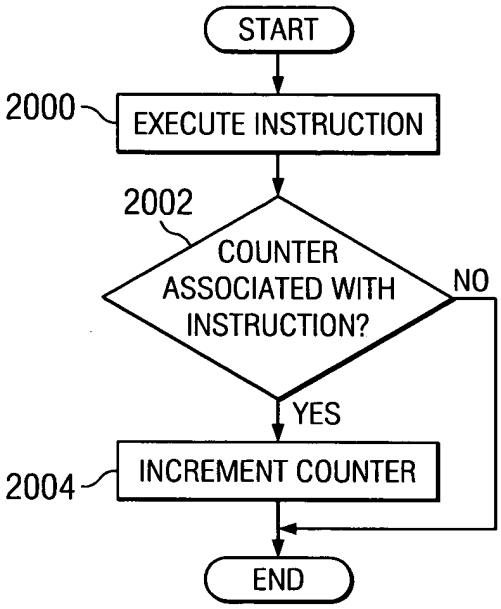
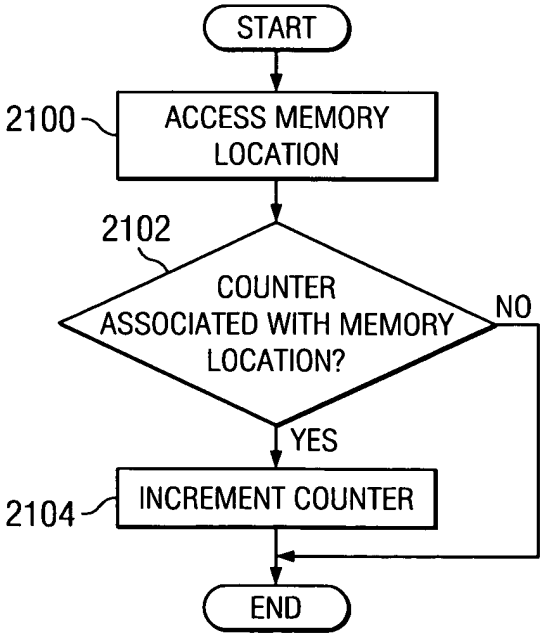


FIG. 21



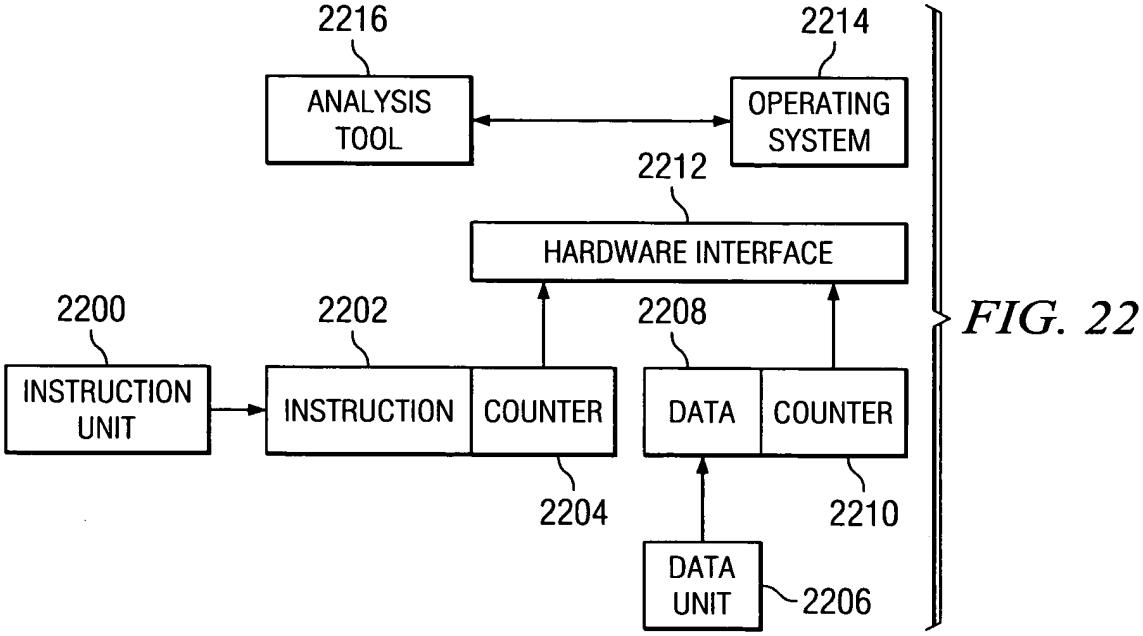


FIG. 22

FIG. 23

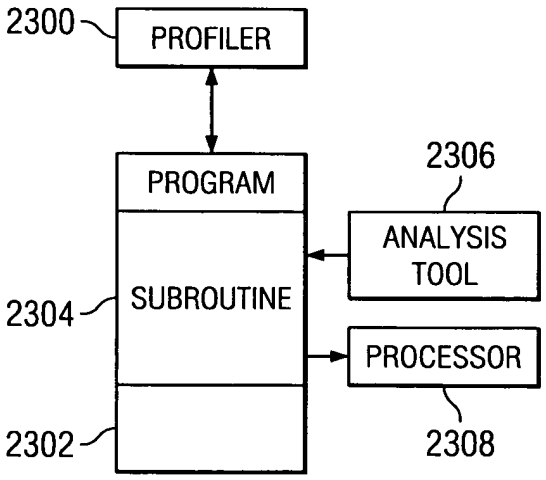


FIG. 24

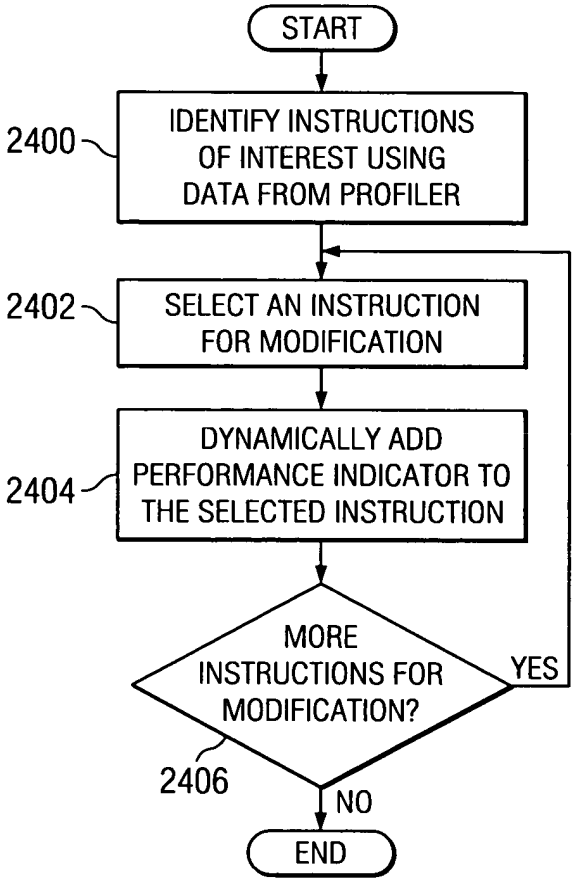


FIG. 25

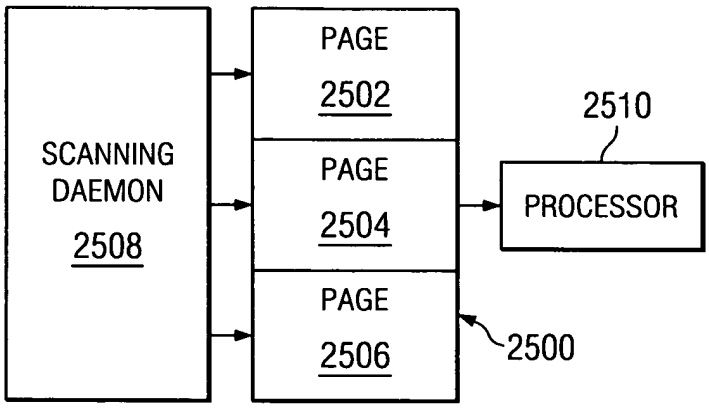


FIG. 26

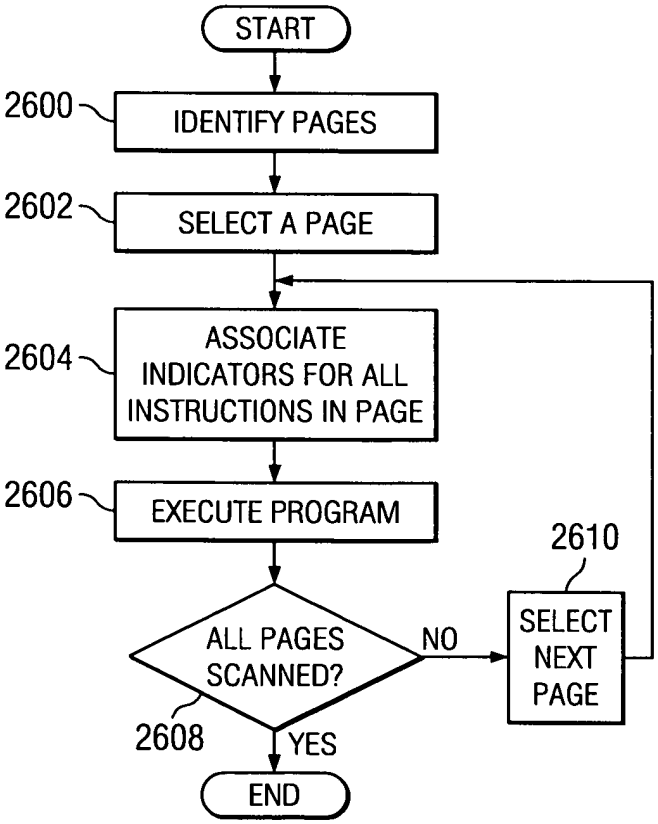


FIG. 27

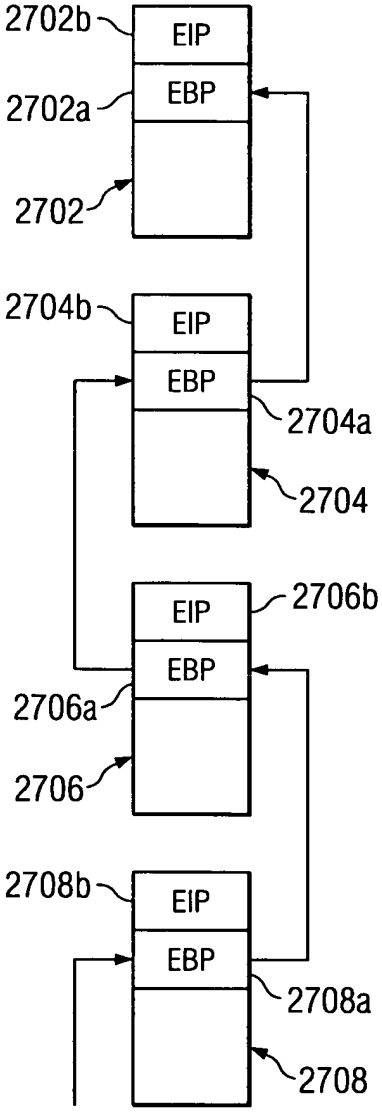


FIG. 28

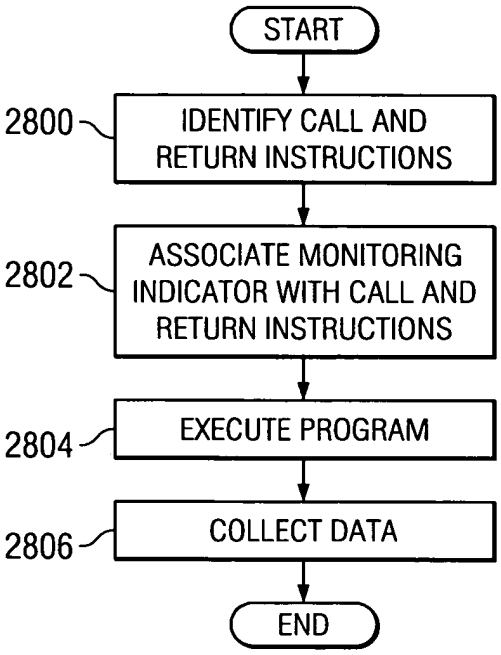


FIG. 29

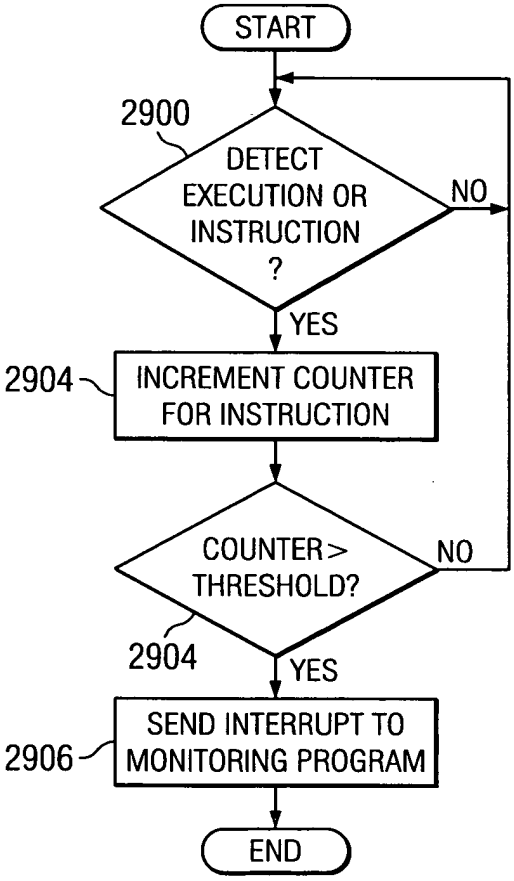
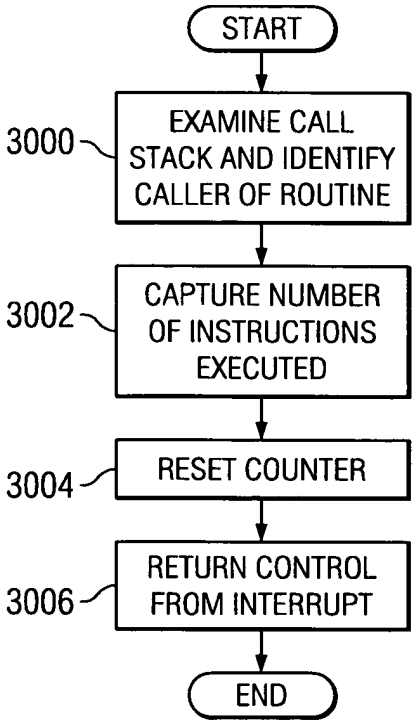


FIG. 30



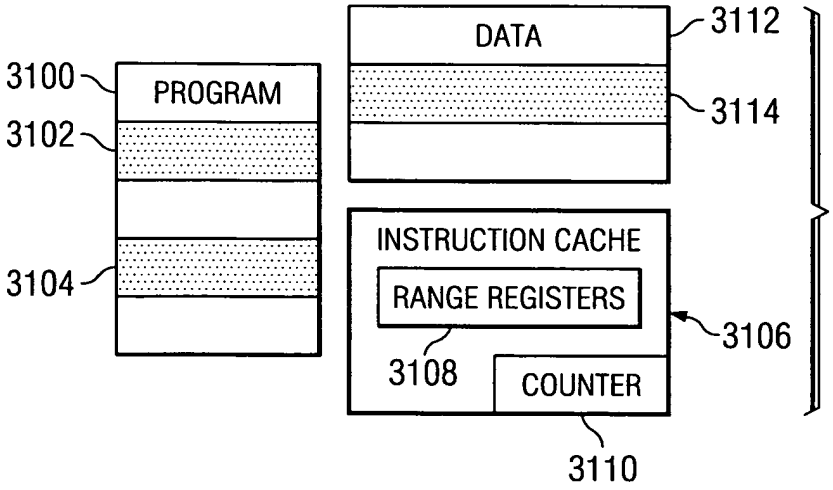

DATA
3112
3100
PROGRAM
3102
3114
3104
INSTRUCTION CACHE
RANGE REGISTERS
3106
3108
COUNTER
3110

FIG. 31

FIG. 32

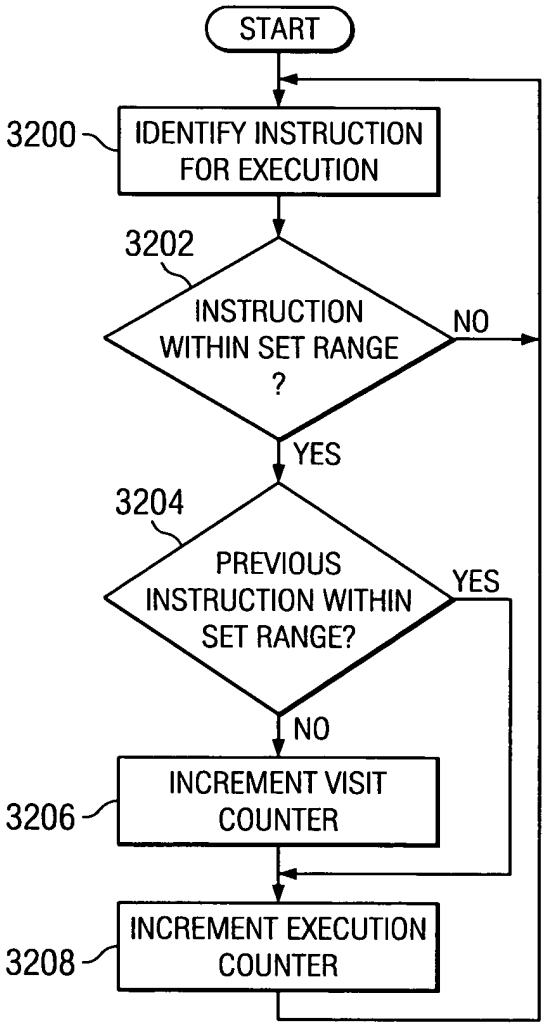

START
3200
IDENTIFY INSTRUCTION FOR EXECUTION
3202
INSTRUCTION WITHIN SET RANGE ?
NO
YES
3204
PREVIOUS INSTRUCTION WITHIN SET RANGE?
YES
NO
3206
INCREMENT VISIT COUNTER
3208
INCREMENT EXECUTION COUNTER

FIG. 33

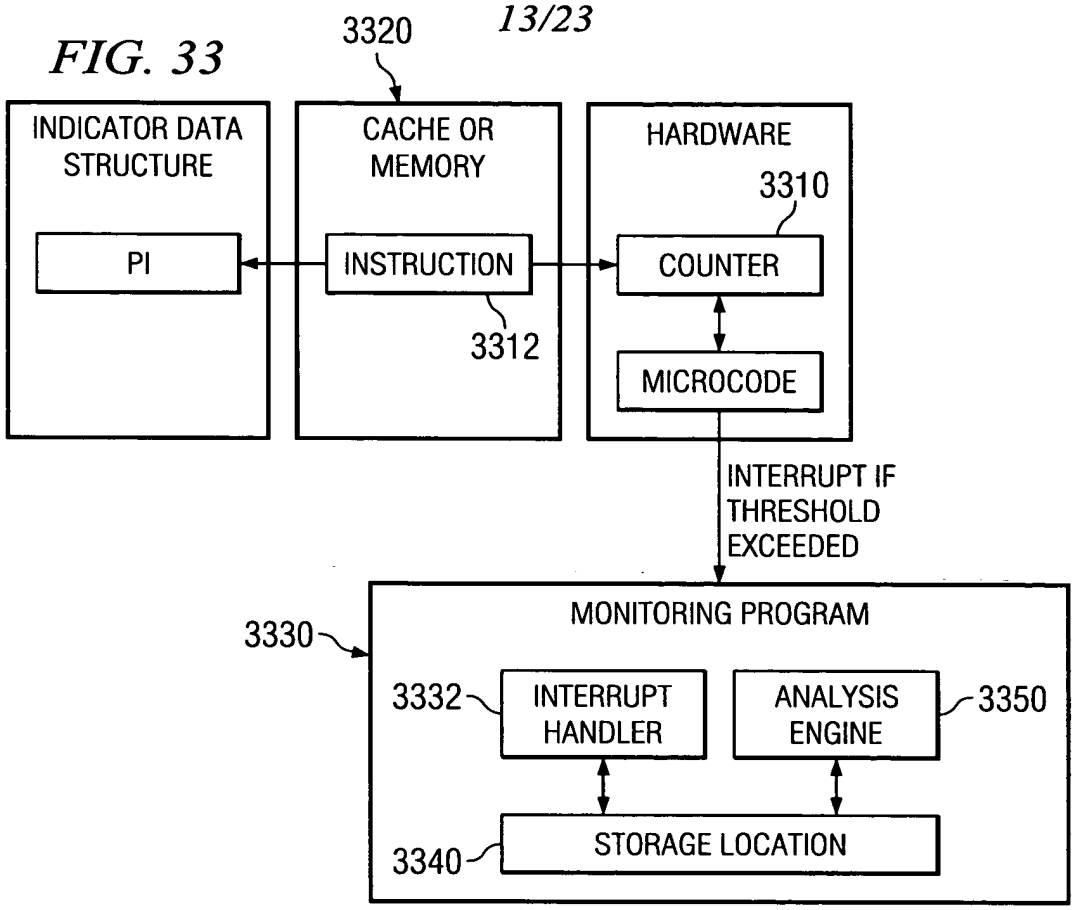

3320
INDICATOR DATA STRUCTURE
CACHE OR MEMORY
HARDWARE
3310
PI
INSTRUCTION
COUNTER
3312
MICROCODE
INTERRUPT IF THRESHOLD EXCEEDED
3330
MONITORING PROGRAM
3332
INTERRUPT HANDLER
ANALYSIS ENGINE
3350
3340
STORAGE LOCATION

FIG. 37

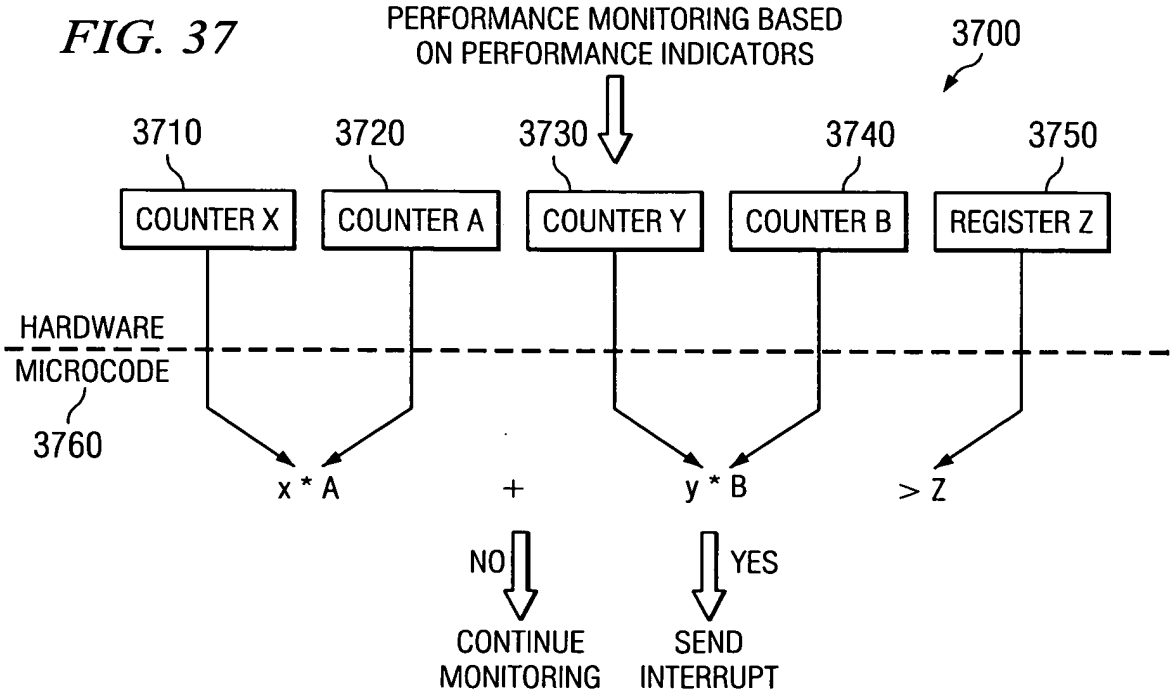

PERFORMANCE MONITORING BASED ON PERFORMANCE INDICATORS
3700
3710
3720
3730
3740
3750
COUNTER X
COUNTER A
COUNTER Y
COUNTER B
REGISTER Z
HARDWARE
MICROCODE
3760
x * A
+
y * B
> Z
NO
YES
CONTINUE MONITORING
SEND INTERRUPT

FIG. 34

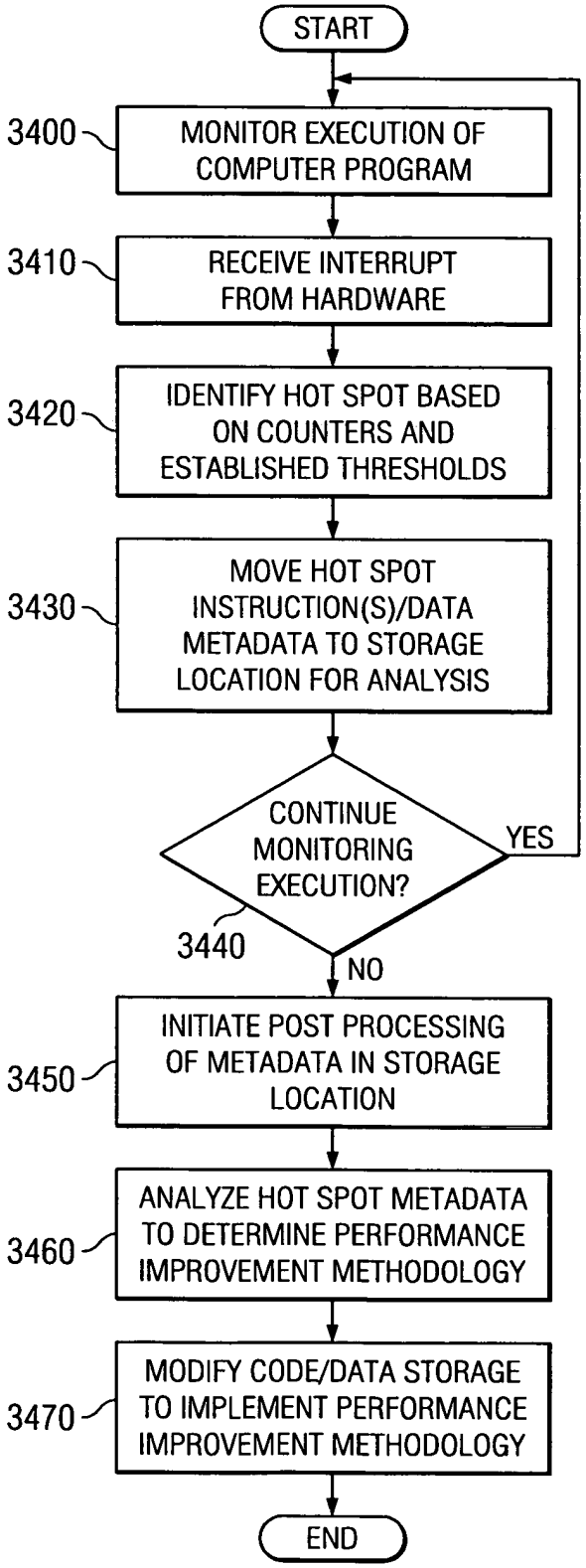


FIG. 35

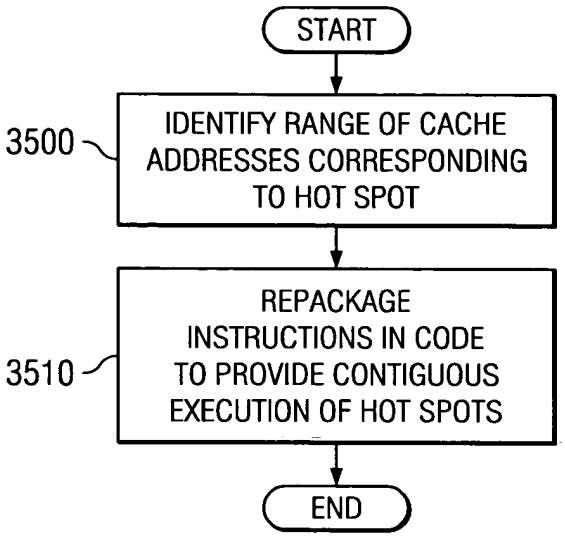


FIG. 36

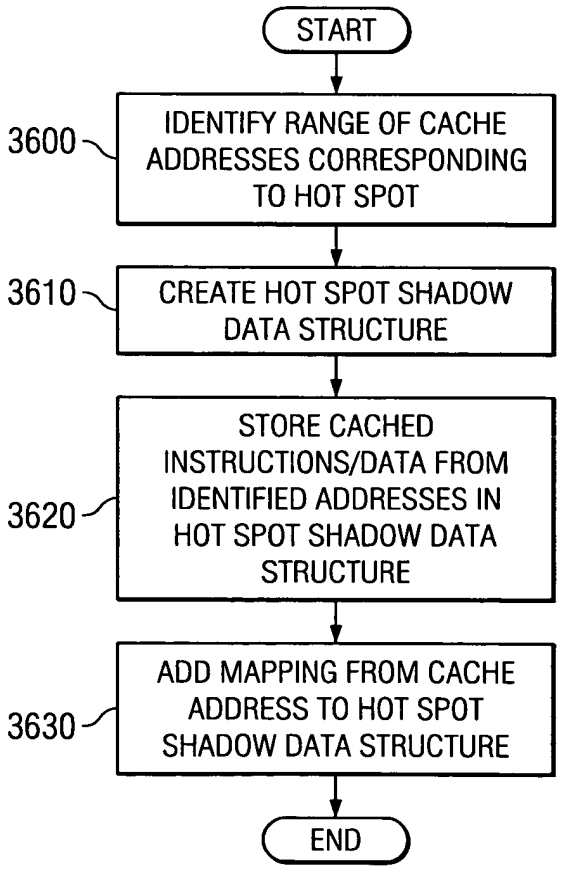


FIG. 38

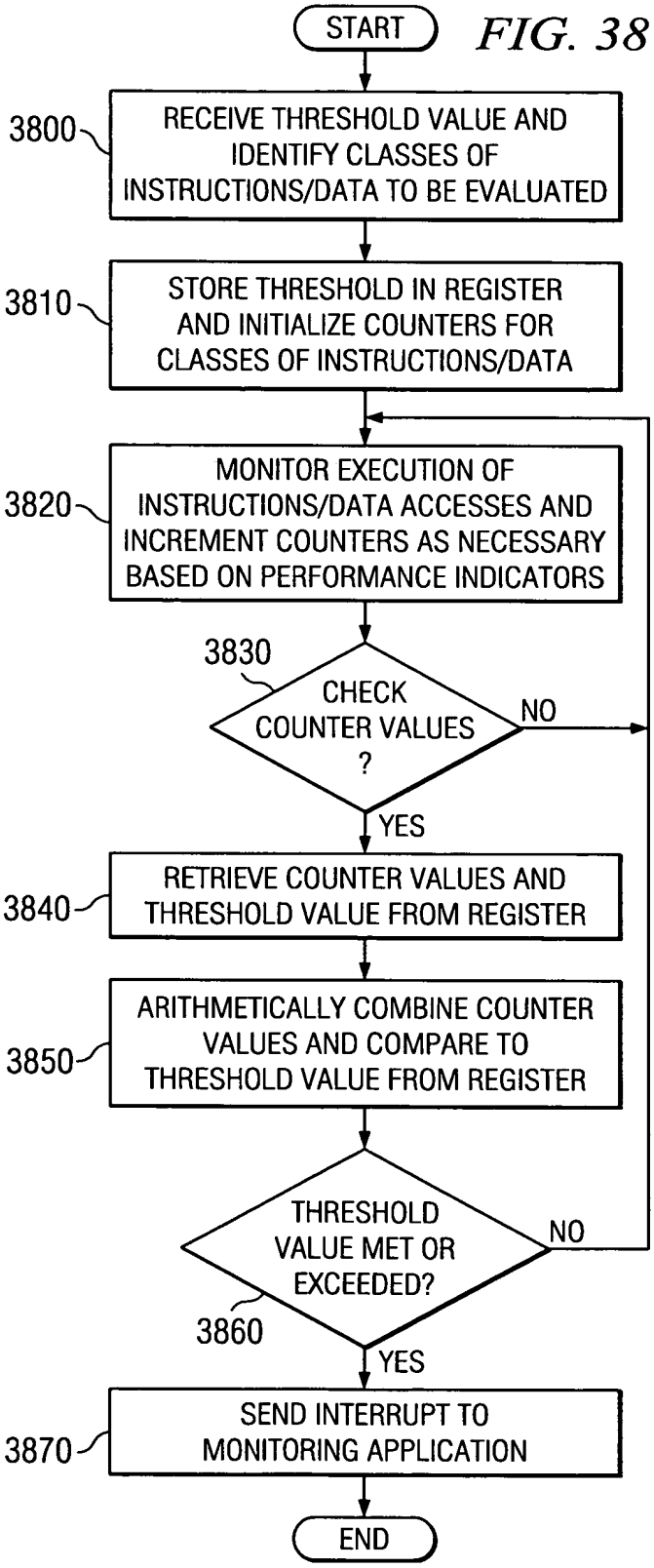

START
3800
RECEIVE THRESHOLD VALUE AND IDENTIFY CLASSES OF INSTRUCTIONS/DATA TO BE EVALUATED
3810
STORE THRESHOLD IN REGISTER AND INITIALIZE COUNTERS FOR CLASSES OF INSTRUCTIONS/DATA
3820
MONITOR EXECUTION OF INSTRUCTIONS/DATA ACCESSES AND INCREMENT COUNTERS AS NECESSARY BASED ON PERFORMANCE INDICATORS
3830
CHECK COUNTER VALUES ?
NO
YES
3840
RETRIEVE COUNTER VALUES AND THRESHOLD VALUE FROM REGISTER
3850
ARITHMETICALLY COMBINE COUNTER VALUES AND COMPARE TO THRESHOLD VALUE FROM REGISTER
THRESHOLD VALUE MET OR EXCEEDED?
NO
3860
YES
3870
SEND INTERRUPT TO MONITORING APPLICATION
END

FIG. 39

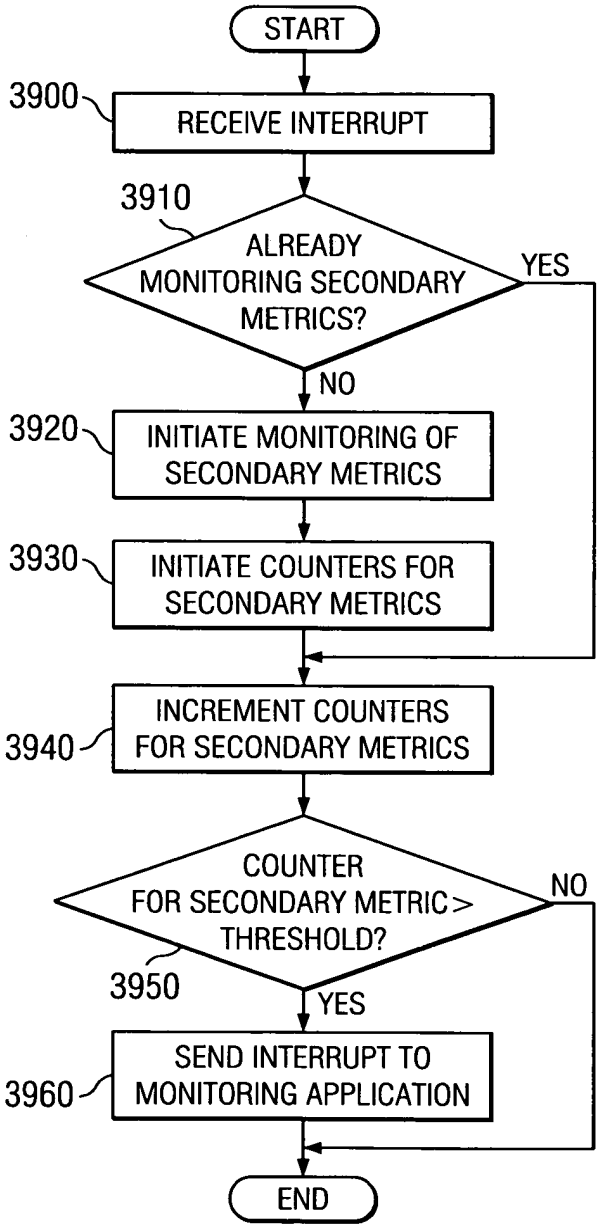

START
3900
RECEIVE INTERRUPT
3910
ALREADY MONITORING SECONDARY METRICS?
YES
NO
3920
INITIATE MONITORING OF SECONDARY METRICS
3930
INITIATE COUNTERS FOR SECONDARY METRICS
INCREMENT COUNTERS FOR SECONDARY METRICS
3940
COUNTER FOR SECONDARY METRIC > THRESHOLD?
NO
3950
YES
SEND INTERRUPT TO MONITORING APPLICATION
3960
END

FIG. 40

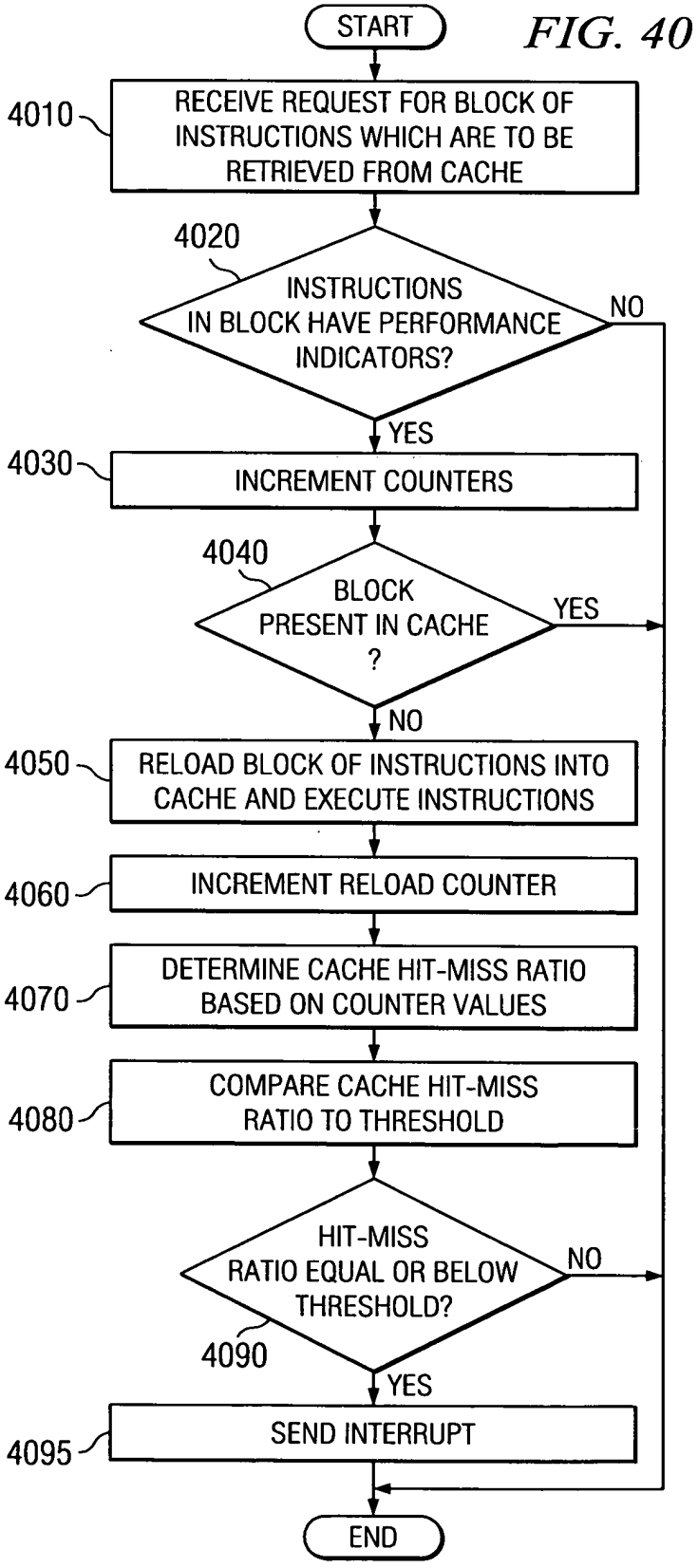
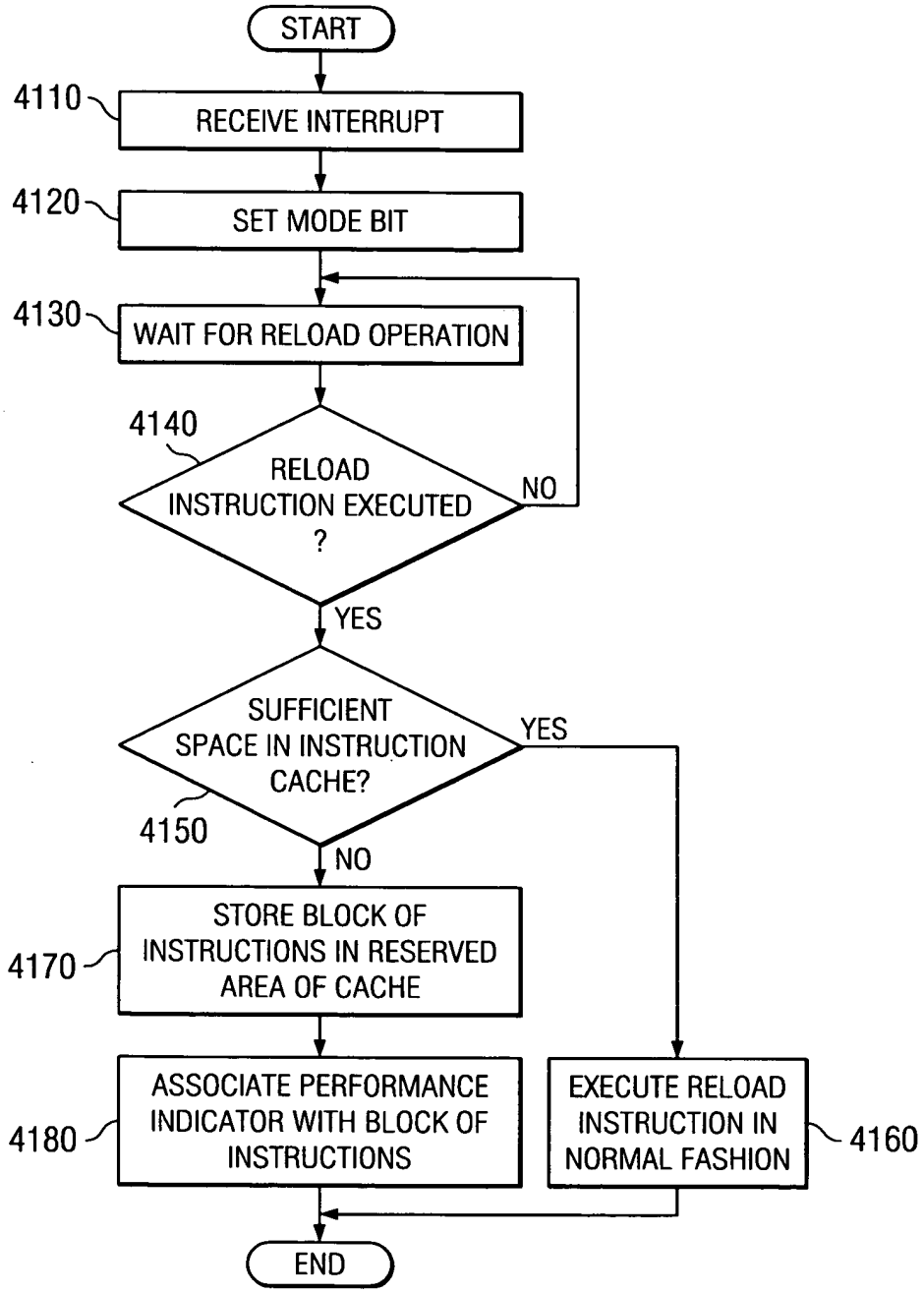

START
4010
RECEIVE REQUEST FOR BLOCK OF INSTRUCTIONS WHICH ARE TO BE RETRIEVED FROM CACHE
4020
INSTRUCTIONS IN BLOCK HAVE PERFORMANCE INDICATORS?
NO
YES
4030
INCREMENT COUNTERS
4040
BLOCK PRESENT IN CACHE ?
YES
NO
4050
RELOAD BLOCK OF INSTRUCTIONS INTO CACHE AND EXECUTE INSTRUCTIONS
4060
INCREMENT RELOAD COUNTER
4070
DETERMINE CACHE HIT-MISS RATIO BASED ON COUNTER VALUES
4080
COMPARE CACHE HIT-MISS RATIO TO THRESHOLD
HIT-MISS RATIO EQUAL OR BELOW THRESHOLD?
NO
4090
YES
4095
SEND INTERRUPT
END

FIG. 41


START
4110
RECEIVE INTERRUPT
4120
SET MODE BIT
4130
WAIT FOR RELOAD OPERATION
4140
RELOAD INSTRUCTION EXECUTED ?
NO
YES
SUFFICIENT SPACE IN INSTRUCTION CACHE?
YES
4150
NO
4170
STORE BLOCK OF INSTRUCTIONS IN RESERVED AREA OF CACHE
4180
ASSOCIATE PERFORMANCE INDICATOR WITH BLOCK OF INSTRUCTIONS
EXECUTE RELOAD INSTRUCTION IN NORMAL FASHION
4160
END

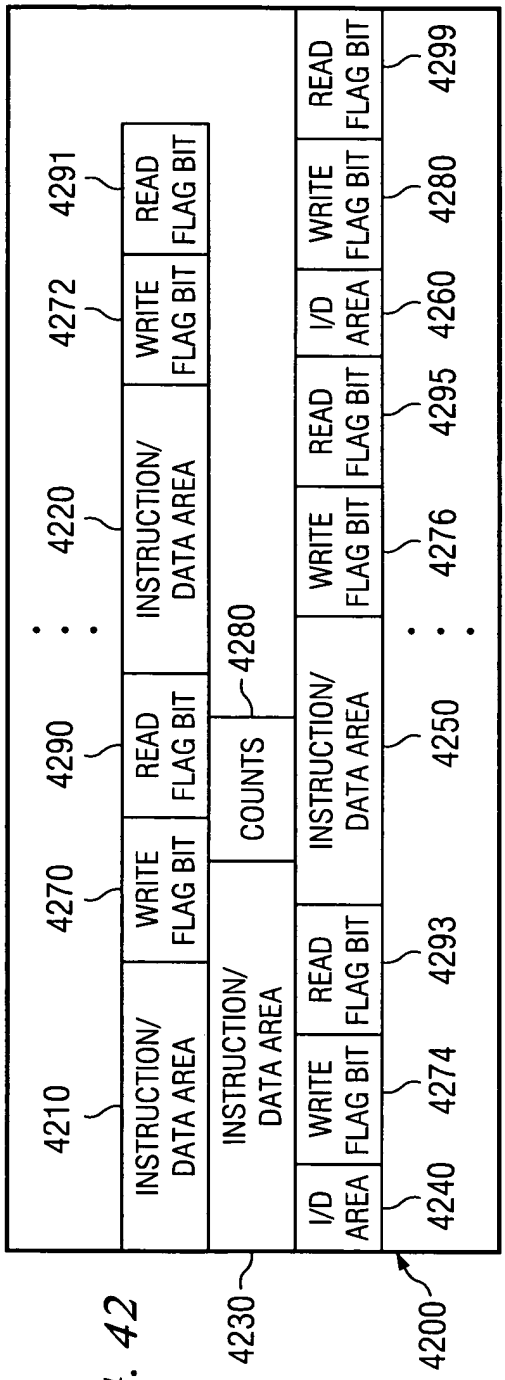


FIG. 42

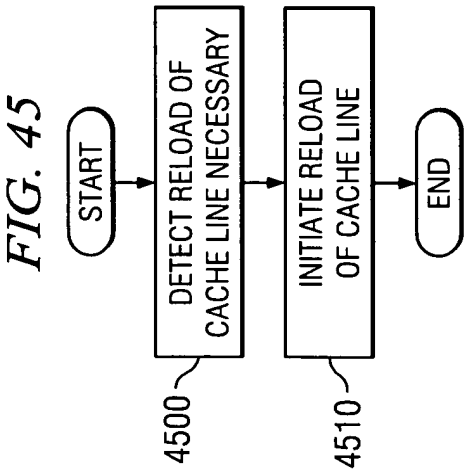


FIG. 45

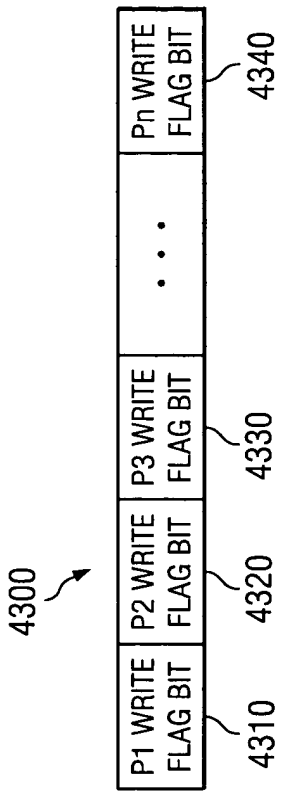


FIG. 43

FIG. 44

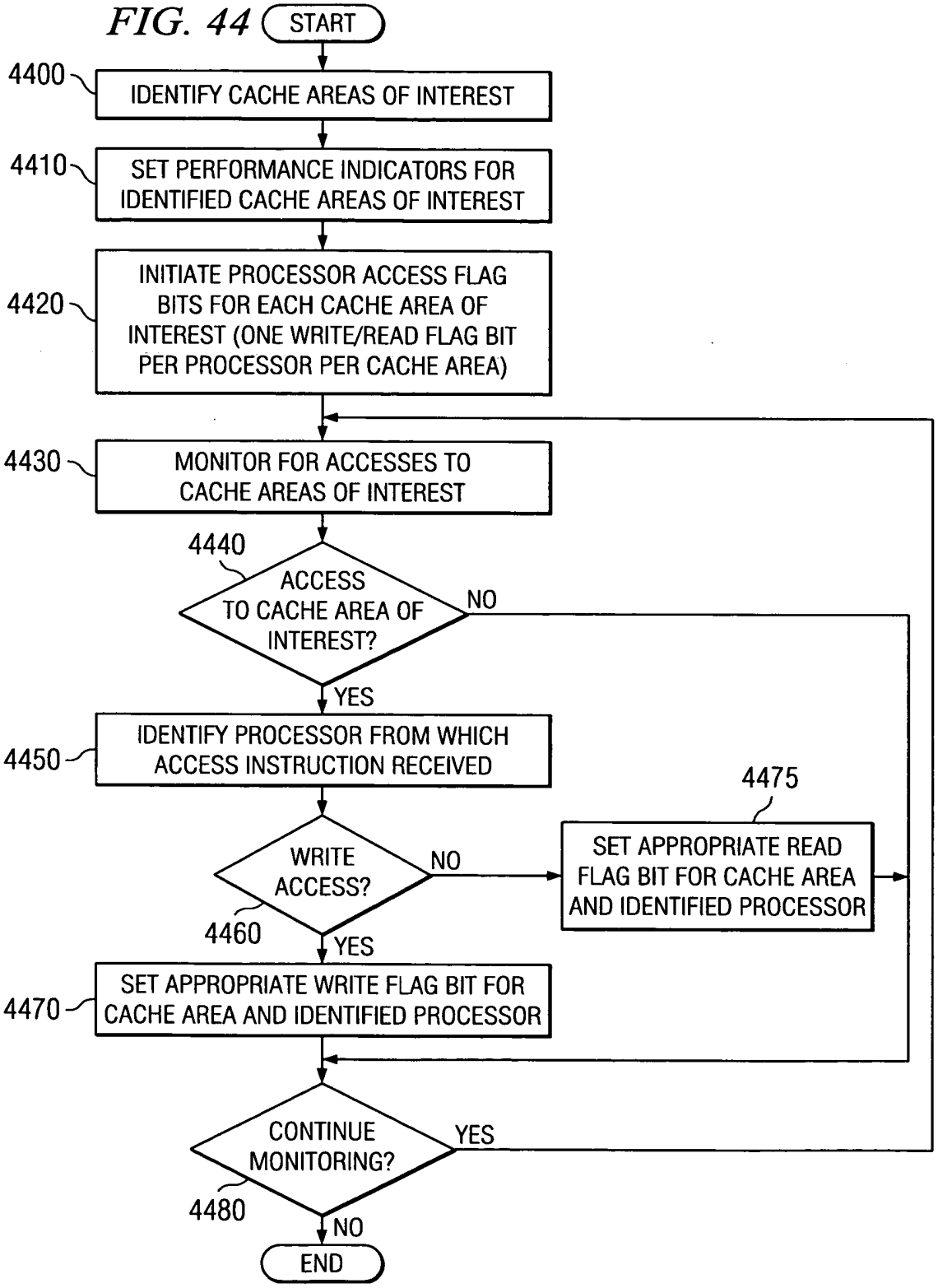

START
4400
IDENTIFY CACHE AREAS OF INTEREST
4410
SET PERFORMANCE INDICATORS FOR IDENTIFIED CACHE AREAS OF INTEREST
4420
INITIATE PROCESSOR ACCESS FLAG BITS FOR EACH CACHE AREA OF INTEREST (ONE WRITE/READ FLAG BIT PER PROCESSOR PER CACHE AREA)
4430
MONITOR FOR ACCESSES TO CACHE AREAS OF INTEREST
4440
ACCESS TO CACHE AREA OF INTEREST?
NO
YES
4450
IDENTIFY PROCESSOR FROM WHICH ACCESS INSTRUCTION RECEIVED
4475
WRITE ACCESS?
NO
SET APPROPRIATE READ FLAG BIT FOR CACHE AREA AND IDENTIFIED PROCESSOR
4460
YES
4470
SET APPROPRIATE WRITE FLAG BIT FOR CACHE AREA AND IDENTIFIED PROCESSOR
CONTINUE MONITORING?
YES
4480
NO
END

FIG. 46

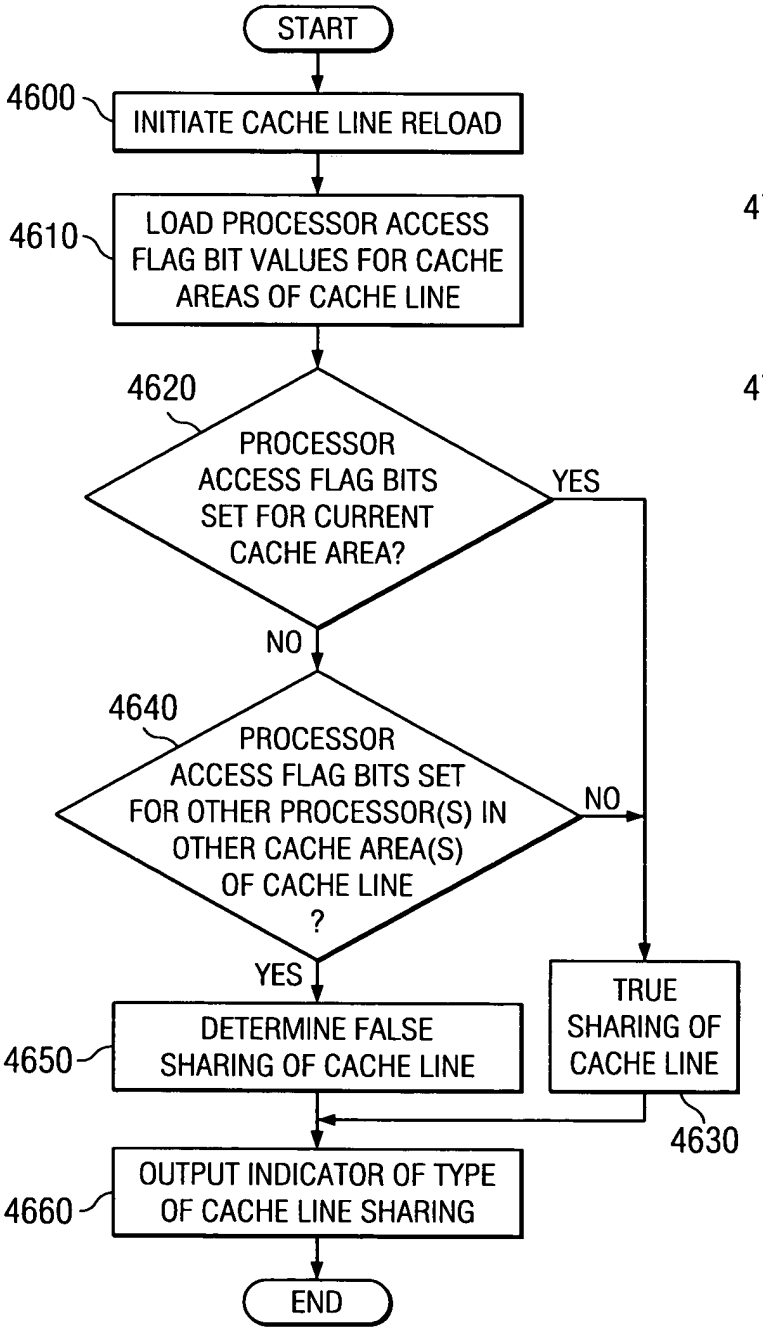

START
4600
INITIATE CACHE LINE RELOAD
4610
LOAD PROCESSOR ACCESS FLAG BIT VALUES FOR CACHE AREAS OF CACHE LINE
4620
PROCESSOR ACCESS FLAG BITS SET FOR CURRENT CACHE AREA?
YES
NO
4640
PROCESSOR ACCESS FLAG BITS SET FOR OTHER PROCESSOR(S) IN OTHER CACHE AREA(S) OF CACHE LINE ?
NO
YES
4650
DETERMINE FALSE SHARING OF CACHE LINE
TRUE SHARING OF CACHE LINE
4630
4660
OUTPUT INDICATOR OF TYPE OF CACHE LINE SHARING
END

FIG. 47

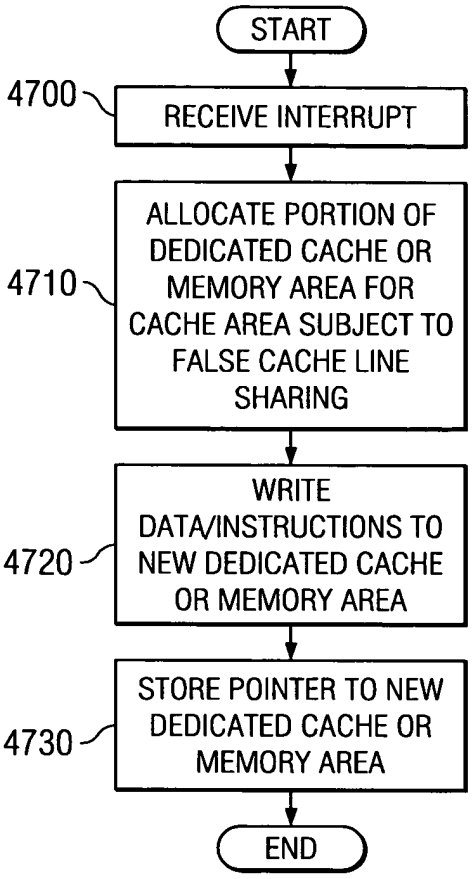

START
4700
RECEIVE INTERRUPT
4710
ALLOCATE PORTION OF DEDICATED CACHE OR MEMORY AREA FOR CACHE AREA SUBJECT TO FALSE CACHE LINE SHARING
4720
WRITE DATA/INSTRUCTIONS TO NEW DEDICATED CACHE OR MEMORY AREA
4730
STORE POINTER TO NEW DEDICATED CACHE OR MEMORY AREA
END

FIG. 48

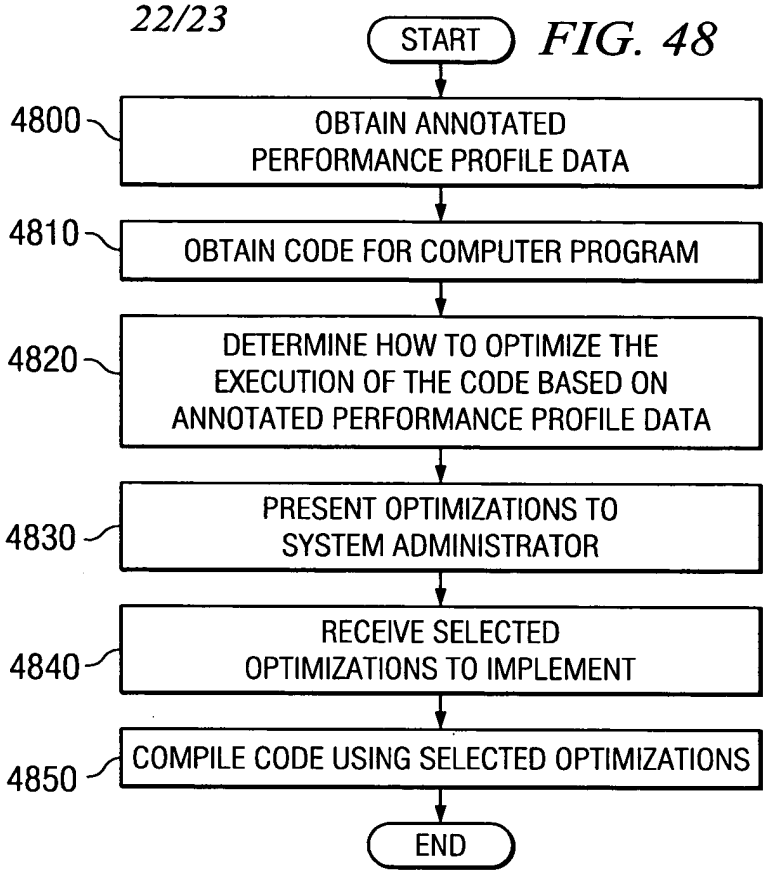


FIG. 49

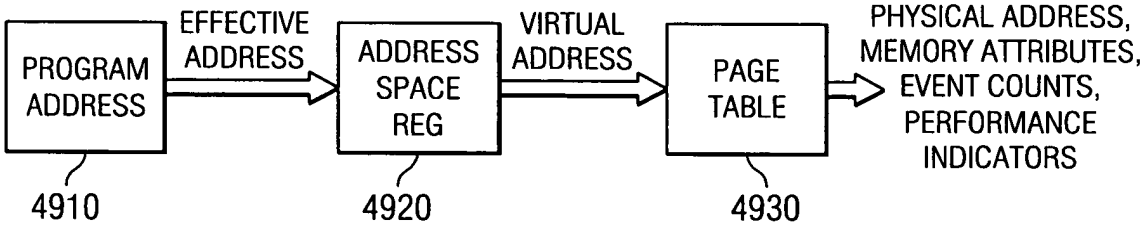


FIG. 50

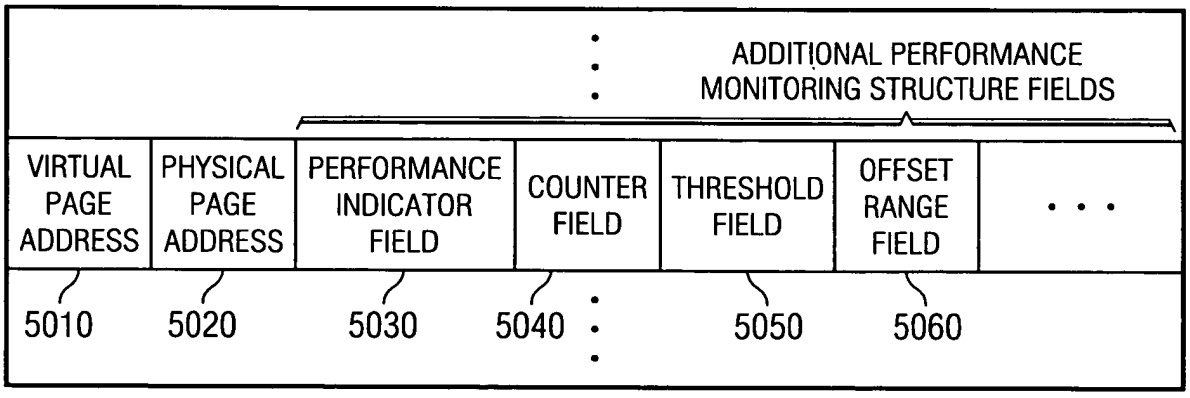
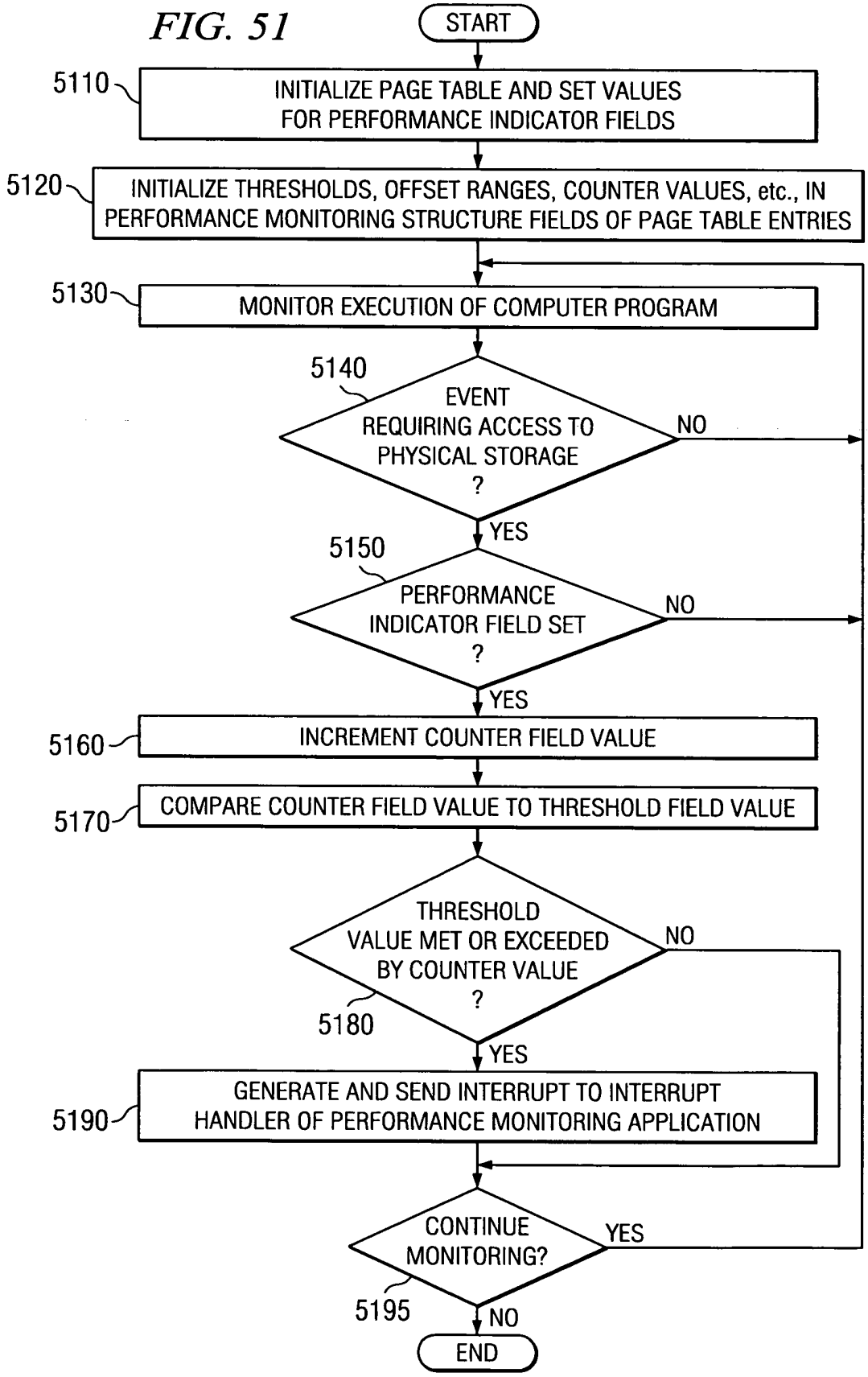


FIG. 51


START
5110
INITIALIZE PAGE TABLE AND SET VALUES FOR PERFORMANCE INDICATOR FIELDS
5120
INITIALIZE THRESHOLDS, OFFSET RANGES, COUNTER VALUES, etc., IN PERFORMANCE MONITORING STRUCTURE FIELDS OF PAGE TABLE ENTRIES
5130
MONITOR EXECUTION OF COMPUTER PROGRAM
5140
EVENT REQUIRING ACCESS TO PHYSICAL STORAGE ?
NO
YES
5150
PERFORMANCE INDICATOR FIELD SET ?
NO
YES
5160
INCREMENT COUNTER FIELD VALUE
5170
COMPARE COUNTER FIELD VALUE TO THRESHOLD FIELD VALUE
THRESHOLD VALUE MET OR EXCEEDED BY COUNTER VALUE ?
5180
NO
YES
5190
GENERATE AND SEND INTERRUPT TO INTERRUPT HANDLER OF PERFORMANCE MONITORING APPLICATION
CONTINUE MONITORING?
YES
5195
NO
END